AMERICAN

RAILROAD JOURNAL,

AND

MECHANICS' MAGAZINE.

No. 11, Vol. IX. New Series.] DECEMBER 1, 1842. [Whole No. 418 Vol. XV.

EXAMINATION OF THE RAILROAD SYSTEM.

No. III.

As railroad companies are liable to all those difficulties and errors which are peculiar to corporate bodies, we must expect to find causes of error peculiar not to the railroad system, but which have nevertheless exercised a powerful control over the system itself. The effects of these we may consider under the general head of

Financial Errors.—Although many of these are only to be unravelled by an inquiry into the mysteries of stock-jobbing, we do not propose to weary our readers with any such investigations but simply to give a general view of those errors which are open and well known to the public.

The first and most striking of these unfortunate agencies which we propose considering is the diversion of a railroad incorporation from its legitimate purposes, and its consequent conversion into what is commonly called "a fancy stock." This has frequently occurred when in times of extraordinary fluctuations in the money market, the stock of a company has suddenly changed hands, and become the property of those who, having no real interest in the prosecution of the work, have used it for any other purpose than that for which it was originally designed. Such we are informed is the condition of several works which are now cited as instances of failures. The generally low and fluctuating state of the stock of such railroads, keeps them constantly in pub-

lic notice, and affords a ready instance for those who declaim upon the unsafe and speculative character of railroad investments. A single glance at any newspaper for several years past, will verify the truth of our assertion.

Another unfortunate influence and one equally foreign to the system itself, has been the connection of banking privileges with the proper business of a railroad. There are not many instances of this, but as far as we know, the result has been uniformly unfavorable. Besides the difficulties which have attended banking operations, it will generally be admitted that the very connection has had an unfavorable influence upon the railroad itself. No wonder then that these should be classed among the "failures."

A third and very important financial error we have recently seen noticed in report of Mr. Garnett's, if we are not mistaken. The writer states that the value of several railroads in the Southern country has been permanently injured by the injudicious policy of making large loans instead of raising the amount required at once by asking for a larger capital. Cases are cited in which although the capital might have been obtained without difficulty, the preference was given to loans, on account, it appears, of the larger dividends to be obtained. The soundness of this argument is certainly not apparent to us, but as we disclaim all pretension to knowledge of finance, we are willing to admit that it may be apparent to others. Whatever may have been the reasons for pursuing this line of policy, the result has been uniformly unfortunate—the raising of money which has been actually refused, when it was offered, has been postponed by the temporary expedient of a loan until a time arrived when the utmost difficulty was experienced in paying the mere interest—and the receipts of the company, were diverted from the proper maintenance of the work, with the design of preserving the credit of the company.

This error seems to have operated with the same results in very many cases, but in some instances at least the cause has been diametrically opposite to the one above named. Companies have been organised and have commenced their operation with an adequate capital, but before the whole has been paid in, the great crisis in the commercial world took place, and the difficulty of calling in the remainder of the capital in a measure compelled the adoption of a policy not originally intended. We have consequently the remarkable case, of companies with but a small portion of their capital actually paid, building their roads entirely upon credit.

Our enumeration of errors would be manifestly incomplete with-

out a notice of a mistake, having the same consequences with those just mentioned, but still another and more culpable origin. We refer to miscalculation of the cost of the work, sometimes the fault of the directors, sometimes of the engineer, and occasionally of both. When this miscalculation is ignorantly made, the parties are certainly blameable, for either gross incompetence, or neglect of duty—but when designedly made it is a criminal act, deserving the punishment it probably does not receive by mere technical evasion. We know of no instance of this fraud, although we are assured that such do exist. In either case, the misfortune of the stockholders is the same, amounting to a partial or even total loss of their investment—and the addition to the list of "failures" thus made, is we fear not a small one.

The financial character of railroads, has also been injured by their connection with other works or operations which not being profitable have diminished the value of the stock and thrown discredit upon railways really profitable. Several important lines of road from being thus situated have appeared to those not aware of the circumstances as weighty objections to the profitableness of railroads generally. Thus one railroad has a canal attached to it, another, an extensive steamboat establishment, a third is obliged to consolidate the various interests and diverse management of the two or three original companies, of which it is constituted. All these things are unknown to the public, yet produce an effect upon the value of the stock which has a serious influence upon capitalists.

The usual quotations of stock are attended with another disadvantage to railroads, although arising from a cause which is really creditable, and shows their value. It is this; while "fancy stocks," are continually noticed at every sale—the best railroad stocks are seldom heard of, and in proportion to their value as investments, are they kept from public notice. A newspaper taken at random, containing a weekly price current, gives no quotation for the stock of three of the best railroads in this portion of the Union. In the same paper are to be found all our City Incorporation and City and State Stocks.

The operations of banks, insurance companies, etc., are upon money almost entirely—those of railroads are far different and hence the ignorance of capitalists upon this point, even when authentic information is accessible to them. Thus we find that the very advantages of railroads have in some measure kept them from public notice and favor, and that in general notoriety is at-

tached only to those works which either from being remarkable failures, or from some other cause have become a sort of foot ball among brokers.

[The following communication contains a suggestion which is new to us, but seems to be well worth consideration. The introduction of Croton Water into the city of New York seems destined to produce a great change in many ways. We notice that our ferry boats now use this water exclusively. The saving of the boilers and the less need for blowing out, have rendered it an object to pay the small sum demanded for the use of the water. After the pipes have been thoroughly cleansed we have no doubt that the water will be found so pure that very little if any sediment will be found after the longest use.]

[To the Editor of the Railroad Journal.]

Some time ago, while at St. John's, N. Brunswick, I strolled, out of curiosity, into the India House there (a large grocery establishment so called) where a small steam engine stands in the window of the shop, and is employed in grinding coffee, sugar, etc. for the retail trade of the shop. In the course of conversation with Mr. McConkey, the proprietor, I found that he saved the power commomly expended in working the force pump for feeding the boiler, by conveying the water to the boiler directly from the Water Company's Street Mains—the pressure of the head between the Company's reservoir and the boiler being more than sufficient for forcing the water into the boiler, and thus the expense of the pumping power is saved.

As this hint may be usefully employed in other places besides St. Johns, you will please to give this an insertion in your widely circulated journal, if you think the hint may be useful. In many places where the pressure of the head of water may be found rather deficient for forcing the water into the boiler, the place for the boiler may be excavated—the boiler placed as low as necessary, and then built in with solid masonry as I understand some of the Cornish engine boilers are, which confines the caloric much better by such jacketing, and consequently must be a great saving of fuel. By taking the boiler water from the street mains wherever it is available, and paying a small tribute over and above the value of the water to the Water Company, the advantage gained will yield a very large proportionate return to the proprietor of the engine, by saving that power which would otherwise be absolutely neces-

sary for working the force pump, unless indeed the charge for the privilege was too exorbitant. R. R.

Nov. 1, 1842.

EASTERN DIVISION,
N. Y. & E. RAILROAD.

To the Assignees of the N. Y. Railroad Company:

GENTLEMEN,—In compliance with your request I submit a general Report of the business of the Eastern Division of the road.

I assume the duties of Superintendent under your direction at the date of assignment on the 16th April last, and the time covered by this exhibit is five and one half months.

The duties I was instructed to perform were

1st. To take charge of and protect the property of the Assignees upon this Division.

2d. To employ the same as far as was necessary in the transportation of passengers and freight so long as it should appear evident that a revenue could be derived from running the road, thereby consulting the interest of the creditors of the Company.

I have in accordance with your instructions made weekly and monthly reports of the business of the road, containing statements of the sums daily received and expended with vouchers therefor, to which I beg leave to refer you for a more minute account of the expenses incurred than can well be contained in a general report.

The road when opened for use in Sept., 1841, was in an unfinished state, through the earth cuts the banks in many places were nearly perpendicular, the ditches were not sufficiently deep or wide to carry off the water, and the embankments in frequent instances had been so much washed by the rains as to require additional earth. These defects had in a great degree been remedied by the Company prior to the assignment, yet much remained to be done to secure the regular and uninterrupted running of the trains through the winter months from the effects of alternate frosts and thaws. A due regard to economy required that this labor should be performed during the summer months. It is now nearly completed, and but little further expenditure for this purpose will be necessary.

It was found that the number of cars was quite inadequate to the economical transmission of the increasing freight, and as the business of the road can be sustained only by regularity and promptitude, it was deemed of the first importance to have the number increased so that in the event of accident by which a train might be disabled, there would be no interruption or delay in the transmission of freight. The failure to carry the *market* freight for a few days would seriously affect the revenue of the road for a long time.

Notwithstanding a considerable portion of the earnings of the road has been expended for the objects above mentioned, it is believed that the interests of the creditors of the Company have been consulted more than if they had been appropriated to the payment

of the claims against the Company. The increasing revenues of the road tend to confirm this belief. Indeed had the Assignees not directed the improvement of the road by the removal of slopes, deepening the ditches, and repairing the track, it would have been impossible to run it, and the only alternative would have been to sell the property of the Division. The personal property consisting of cars, engines, etc., being adapted to a six foot track, are worthless for any other road in the United States, and would of course be sold only for the value of the materials. It was evident from the past revenues of the road that the Assignees would be enabled by the *use* of this property to pay all the indebtedness of the Eastern Division without depreciating the value of the machinery and fixtures belonging to it.

In conducting the business of the road the general rules adopted by the Company have been adhered to. The tolls on freight have been changed but on one article. The salaries of the Agents have been reduced, and the numbers employed is barely sufficient to perform the necessary duties.

Had the Assignees found the road properly prepared for economical management, the shops in order and well supplied with Machinery, together with Engines and Cars sufficient to accommodate the business to be done, they could have introduced still greater economy in the Departments of Repairs and operations, and many of the expenditures which have been incurred might have been postponed until the first class creditors were paid. Having but a sufficient number of cars for two freight trains, none can be left, or only occasionally, at either terminus, or at intermediate stations for loading, but each car is required to pass up or down the line daily, receiving and discharging freight.

The whole machinery of the road at the time of the assignment, consisted of

5 Locomotives,
4 Passenger Cars, 8 wheels,
13 eight wheel body Freight Cars,
3 do Cattle Cars,
5 do Platform Cars, 2 unfit for use.

This outfit has been increased by the Assignees as follows:

2 eight wheel Passenger Cars,
2 do Cattle Cars, and
2 four wheel Body Cars, for Freight.

The freight cars first mentioned were, when furnished by the builders, unfit for use. The weight of the cars was about 7 tons, and the wheels and axles were of sufficient strength to carry 2 tons per journal, but the draws and bearing springs and truck frames, would carry from 7 to 8 tons only. These parts had to be replaced and the roofs re-covered. This work was in progress prior to the assignment, but much of it has been done since, and the capacity of the cars has been increased about one-third.

Since the assignment there have been transported in these cars an amount equal to 424,329½ tons one mile. The whole distance

travelled by the cars has been 96,733 miles. The number of tons carried by each journal one mile has been at the rate of 5260 tons per year.

Full statistics of the work performed by the Engines and cost of transportation, are annexed.

It should be borne in mind that the curves and grades of the Eastern Division of the road, are unfavorable to cheap transportation, but the statistics will show that the *tonnage* per mile (with one Engine) compares favorable with more level roads and consequently the cost per ton.

The curvature of the 46 miles is equal to 2767 degrees, and the rise and fall to 1706 feet, rise going West being 1064 65, fall, 641 5 feet, and grades of 60 feet in the same direction are equal to 9½ miles, and East 7 and 42 one hundredth miles.

It has not been our object to show that the road has been worked cheaper per mile *run* than others, for we might have run a greater number of miles with the same Engines, and performed the same business and not have increased our expenses in proportion. Our object *has* been to show that under the circumstances of the road outfit and business, the work has been done as cheaply per *ton* per mile as elsewhere.

Our *charges* are *per ton, per mile*, and not per *mile run*. Our rule is to run as few miles as possible with a given quantity of freight or to tax the Engine to her maximum power whenever a sufficient amount of freight is on hand. The freight trains have sufficient time given them to avoid fast running, and should a storm occur so as to slip the wheels on any of the 60 feet grades, (for which the limit of load is fixed) a portion of the load is left, and the remainder is placed on a side track at the top of the grade, and the Engine returns for the cars which were left. This seldom happens, and the distance thus travelled is not taken notice of. The greatest tonnage taken by one Engine over the road is 90 9-10th tons or nett freight useful load.

We also allow a higher pressure of steam than is usual on most roads, and keep in view the repairs and construction of our cars, a load equal to 1¾ tons per journal, that we may reduce the weight of cars per ton of useful load.

We thus undoubtedly increase the cost per mile run for our freight trains, but should such increase amount to 20 cents per mile, and the average load be increased 10 tons, then

46 miles at 20 cents,	$9,20
and 10 tons at $2,30,	23,00
will show a saving of	$13,80 per trip.

By separating the expenses of the Ferry from the Railroad it will be seen that the cost of the freight train has been 106½ cents per mile run, and of the passenger train 45 cents, and the average of freight and passenger $72\frac{44}{100}$ cents per mile run. The cost per ton per mile has been $2\frac{97}{100}$ cents, and per passenger per mile $1\frac{614}{1000}$ cents. The average *charge* per ton per mile, including loading and

unloading is $5\frac{2}{100}$ cents, and per passenger per mile is 2,64 cents.

It cannot be supposed that upon a road where the charges are so low, the nett revenue will bear the same porportion to the earnings as upon roads where the charges are much higher. The usual charge upon most roads is for passengers 4 cents per mile, and for freight $5\frac{1}{2}$ to 8 cents per ton, per mile.

The Assignecs are aware that the Ferry is a charge upon the revenues of the road, but it is believed that this service is performed at as cheap a rate as can be obtained under an arrangement which would secure its performance during the whole year.

The following exhibit of the revenues and expenditures will show how much has been appropriated to the different objects here explained. A much larger portion of the nett revenue it is believed can soon be appropriated to the payment of the creditors of the Company.

Very Respectfully.

H. C. Seymour.

Piermont, 20th October, 1842.

The earnings of the Division from the 16th of April to the 30th of September, have been as follows:

FROM FREIGHT.

Eastward tonnage	11,905,103 lbs.	and revenue	$13,463 73
Westward do	12,072,443 do	do	12,724 29
Total do	24,877,546	total do	$26,188,02

FROM PASSENGERS.

From passengers Eastward	24,741½	$10,158 94	
From passengers Westward		11,400 22	
Total,			21,539 16
Total earnings R. R. & Ferry,			$47,747 18
Of which the R.R. portion is		$37,138 24	
And Steamboat's portion		10,608 94	

The expenditures during the same period on account of transportation have been:

FOR REPAIRS.

Of Locomotives,	$757 28	
Of Freight Cars,	1,105 61	
Of Passenger do,	228 40	
Of Buildings,	30 05	
Of Superstructure,	1,915 78	
Of Grading,	32 07	
Of Work Shops,	7 48	
Total		4,076 67

COST OF RUNNING.

Engine and Firemen,	$1,285 72
Conductors and Brakemen,	1,527 83

Fuel,	$2,745 44	
Oil and Waste,	481 47	
Running Contingencies,	60 62	
Total,		6,101 08

GENERAL EXPENSES.

Superintendence,	$1,375 00	
Agents and Clerks,	2,512 04	
Stationary, etc.	381 17	
Car House Attendants,	419 58	
Loading and unloading,	2,391 96	
Contingencies,	640 00	
Total,		7,719 75
Total expenditures of the Railroad,		$17,897 50

FERRY EXPENSES.

Steamboat Charter,	12,630 00	
do Labor,	450 00	
	$13,080 00	
Barge Charter,	825 00	
do Labor,	990 00	
	1,815 00	
Incidentals,	339 89	
Total Ferry Expenses,		15,223 89
Total Expenses of R. R. and Ferry,		33,132 39
Nett Revenue,		$14,614 79

Expenses during the same period otherwise than for transportation incurred by Assignees.

For materials and fuel purchased for use since Sept. 30th.,	$1,237 92
For removing 5,249 cub. yards of earth from slopes and ditches,	1,431 05
For laying track and spiking and construction of switches,	197 58
For land expenses and fencing,	13 00
For roofing and enclosing machine and work shops, offices, wood houses and water stations,	1,590 46
For purchase and construction of cars and machinery,	3,509 49
For Agents, office expenses, and general expenses of assignment, including legal expenses,	2,680 29
For cash paid to Creditors,	3,509 82
For unappropriated,	345 78
	$14,614 79

ABSTRACT OF EXPENDITURES.

On account of Passenger Transportation from April 16th to September 30th, 1842: together with the service performed, the cost per mile, and per Passenger per mile.

DISTANCE *Run by Engines in miles.*	TOTAL PASSENGERS *Conveyed equal to one mile.*
Total, 13,392	Total, 594,500
AVERAGE NUMBER OF PASSENGERS *For every mile run.*	
Total, $44\frac{3}{10}$	

Items of Expenditures.	Amount.	Cost per mile.	Cost per Pas. per mile.
	$ cts.	$ cts fr	cts. m. fr.
MACHINERY.			
Repairs of Locomotives,	428 92	3 29	72
" Passenger Cars,	228 40	1 71	39
" Machinery in Shops,	3 74	03	00
Total,	661 06	4 94	1 11
WAY AND BUILDINGS.			
Repairs of Buildings,	15 05	11	02
" Superstructure,	1,015 78	7 59	1 71
" Grading,	16 57	12	03
Total,	1,047 40	7 82	1 76
OPERATING.			
Engineers and Firemen,	428 64	3 20	72
Conductors and Brakemen,	509 28	3 80	86
Fuel,	1,276 95	9 54	2 16
Oil and Waste,	206 34	1 54	35
Running Contingencies,	30 31	23	05
Agents and Clerks,	550 00	4 11	93
Stationary, etc.,	95 30	71	16
Car-House Attendants,	219 00	1 63	36
Total,	3,315 82	24 76	5 59
GENERAL EXPENSES.			
Superintendence,	687 50	5 13	1 16
Contingencies,	315 00	2 35	53
Total,	1,002 50	7 48	1 69
Grand Total for Passengers,	6,026 78	45 00	1 0 15

Total cost upon railroad for freight and passenger transportation from April 16th to September 30th, 1842, is $17,897 50, and the average cost per mile run is $72\frac{666}{1000}$ cents.

ABSTRACT OF EXPENDITURES.

On account of Freight Transportation from April 16th to September 30th, 1842; together with the service performed, the cost per mile, and per ton per mile.

DISTANCE	TOTAL TONNAGE
Run by Engines, in miles.	Conveyed distances equal to carrying the whole one mile.
Total, 11,172	Total 424,329 $^{343}_{1000}$

AVERAGE TONNAGE

For every mile run each month.

Total, 37 $^{981}_{1000}$

Items of Expenditure.	Amount	Cost per mile run	Cost per ton per mile
MACHINERY.	$ cts.	$ cts. fr.	cts. m. fr.
Repairs of Locomotives,	328 36	2 93	77
" Freight Cars,	1,105 61	9 90	2 60
" Machine Shops,	3 74	03	01
Total,	1,437 71	12 86	3 38
WAY AND BUILDINGS.			
Repairs of Buildings,	15 00	13	03
" Superstructure,	900 00	8 06	2 12
" Grading,	15 50	14	04
Total,	930 50	8 33	2 19
OPERATING.			
Engine and Firemen,	857 08	7 67	2 02
Conductors and Brakemen,	1,018 55	9 12	2 40
Fuel,	1,468 49	13 15	3 46
Oil and Waste,	275 13	2 46	65
Running Contingencies,	30 31	27	07
Agents and Clerks,	1,962 04	17 56	4 62
Stationary, etc.	285 87	2 56	67
Car-House Attendants,	200 58	1 80	47
Loading and Unloading,	2,391 96	21 41	5 64
Total,	8,490 01	76 00	2 0 00
GENERAL EXPENSES.			
Superintendence pro rata,	687 50	6 15	1 62
Contingencies,	325 00	2 91	77
	1,012 50	9 06	2 39
Grand Total for Freight,	11,870 72	1 06 25	2 7 96

NOTES.—Going west, the total ascent is 1064 $^{65}_{100}$ feet, and descent 641 $\frac{1}{2}$ feet. Grades of 60 feet ascending 9 $\frac{1}{2}$ miles, descending 7 $^{42}_{100}$ miles. Total curvature is 2767 degrees.

12,345 $^{2}_{100}$ tons of freight were loaded into and unloaded from the cars from April 16th to September 30th.

The maximum load in September westward was from Piermont to Laurel Hill, 11 miles, 90 $^{2}_{10}$ tons.—maximum load eastward in September was, from Blauveltville to Piermont, 5 miles, 83 $^{4}_{10}$ tons. The average load weastward in September from Blauveltville to Clarkstown, was 63 $^{733}_{1000}$ tons; and eastward from Tallman's to Monsey was 53 $^{745}_{1000}$; ascending the highest grades, and passing the shortest curves.

HYDRAULIC PROPULSION ON RAILWAYS.

Of the many plans to which the fertile ingenuity of the present day has given birth, for the purpose of diminishing the cost and danger of railway locomotion, the most novel in design, and amongst the most recently invented, is the Hydraulic Railway, for which Mr. Shuttleworth, of Manchester, has taken out a patent. The principle of the invention was announced 12 months ago, but the patentee has since made considerable alterations in his original plans for carrying his design into execution. For the purpose of making it more generally known, he has just published a pamphlet setting forth the claims of his invention, describing at great length its proposed mode of operation, and calculating minutely the advantages to be derived from the adoption of this system of propulsion on railways. Independently of the ingenuity of the invention which claims notice on that account alone, the consideration of the subject gives rise to some interesting questions relative to the motions of fluids, that well deserve attention. We propose, therefore, shortly to describe Mr. Shuttleworth's invention; to state the principal grounds and calculations on which he rests its claims for adoption; and by an examination of the phenomena and laws of hydrodynamics bearing on the subject, to ascertain whether this mode of propulsion can be rendered practically available.

The arrangements proposed by Mr. Shuttleworth for carrying his plan into operation, are in their general features similar to those of the atmospheric railway. A pipe a foot in diameter, with a longitudinal slit on the top, is to be fixed between the rails. Within this pipe a piston is to work, which is to receive the propelling impulse, and communicate it to the carriages by means of a connecting rod passing through the opening at the top of the pipe; which slit is to be kept closed by a continuous valve. So far the two plans exactly agree, and in Mr. Shuttleworth's first proposed mode of working the hydraulic railway, its resemblance to the atmospheric was still further continued. His intention was then to employ an exhausting pump, worked by a stationary engine, the pipes being filled with water. The advantage proposed to be gained by employing water instead of air in the pipes was the greater facility by which a vacuum could be obtained by exhausting an inelastic fluid. At that period Mr. Shuttleworth did not seem to have made sufficient allowance for the friction of the water in the pipes, nor for the weight of water the stationary engine would have had to drag along with great velocity. The resistance presented by these causes of retardation would, however, have required far more power to overcome than the weight and friction of a rope, the disadvantage of which it was a principal object of the invention to obviate. It is true, that Mr. Shuttleworth from the first development of his plan contemplated the occasional application of the direct pressure of a column of water, as an additional means of propulsion; but he seemed to rely principally on the power to be

gained by the pressure of the atmosphere on the water forced through the horizontal pipes, to supply the place of the water pumped from that portion of the pipe in advance of the piston.

The plan of working by hydraulic propulsion now proposed, which is detailed at great length in the pamphlet before us, has effected a complete change in the mode first intended. Mr. Shuttleworth now relies entirely for the propulsive power on the pressure of a column of water, acting against the pressure of the atmosphere, without any exhaustion. He proposes to have reservoirs of water, of sufficient height to produce a pressure of six atmospheres, placed at short distances along the line of railway. From these reservoirs vertical pipes, of the same diameter as the horizontal, are to convey the water to the commencement of each section of propulsive piping. The length of each of these sections is to be about 70 or 80 yards, and the termination of each section of propulsive piping Mr. Shuttleworth proposes to connect with double its length of what he terms "skeleton piping," along which the railway carriages are to be propelled by the momentum previously acquired. In the intervals between the running of the trains, it is proposed to employ stationary engines of great power to pump the water back again to the elevated reservoirs.

The foregoing is an outline of the principal features of the hydraulic railway. The advantages which are expected to result from its adoption are, diminished cost in the mode of working, increased safety, by the avoidance of collisions, and greater facility in the construction of railways in hilly countries. Mr. Shuttleworth makes various calculations for the purpose of showing the economy of his system of propulsion compared with that by locomotive engines; but into these details we do not propose now to enter. Our present purpose is to examine the principles on which he founds the hydraulic mode of propulsion; for if these prove to be defective, as we believe them to be, it will be useless to inquire further.

The first great error into which we conceive Mr. Shuttleworth has fallen, is in the calculation of the initial velocity that could be communicated to the carriages by a vertical column of water of the same diameter as the horizontal pipe. He professes to take all his data from the best authorities in hydrodynamics, among whom Mr. Tredgold ranks foremost, and it is only due to Mr. S. to say that he claims no more in favor of his plan than the calculations of the authorities he relies on seem to warrant. His fault, like that of many other ingenious inventors, lies in the attempt to apply general principles to particular circumstances wherein those principles are inapplicable. Founding on Mr. Tredgold's formulæ, Mr. Shuttleworth estimates the velocity of water rushing from the bottom of a column 198 feet high to be equal to 67¾ miles an hour; this, therefore, he assumes to be the initial velocity which might be communicated to the train of carriages on the hydraulic railway. Now, granting that water would rush from a small aperture at the bottom of such a vertical column with a velocity of 67¾ miles an hour; we cannot concede that the *whole column* would rush out

with that velocity. According to theoretical estimates, water rushes from an orifice with the velocity which a body falling freely would acquire in moving through a space equal to the height of the water above the orifice; but many circumstances may cause the velocity of the issuing fluid to deviate from this general law. If the size of the aperture approximate to that of the tube, the velocity will be diminished; and if the aperture be of the same size as the tube, so that the whole column of water must fall as rapidly as the issuing fluid, the velocity will be diminished one half, without making any allowance for friction. That this must be the case will appear from the circumstances attending the fall of a column of any other body the particles of which cohere. The accelerated motion acquired by all bodies in their descent, would naturally give to the water towards the bottom of the vertical pipe a much greater velocity than to the water at the top; and were the particles of the fluid without cohesion, they would separate into drops in their fall, instead of acting in one connected column. The cohesion of the particles is, however, sufficient to prevent this separation, and the fluid column must, therefore, move with an uniform velocity, in the same manner as a chain or a rope thrown over a pulley must fall throughout its whole length with uniform velocity. The lower portions of the water or chain which, if detached, would move with greatly accelerated velocity, are retarded in their descent by adhering to the more slowly moving portions above, to which they in turn impart some of their superior momentum gained in the descent. The communication of velocity from the lower portions of the falling column to the upper is evidenced in the flow of water down pipes, by the force with which the water in the reservoir is drawn into the pipe; which force increases with the height. It thus appears, that the resulting velocity of a vertical column of water must be the average motion given by gravitation to the whole; or less than half that which Mr. Shuttleworth calculates would be the initial velocity in his system of propulsion. He might, it is true, obviate this difficulty by greatly enlarging the size of the conduit pipe, but this would materially add to the cost of construction.

Another important error appears in Mr. Shuttleworth's calculations in consequence of the velocity of water flowing freely being considered the measure of its propulsive effort. Now, it is very obvious, that any effort required to propel the train of carriages on the railway must diminish the velocity of the acting fluid; and that in proportion to the velocity communicated to the train, the propulsive effect of the fluid pressure must diminish; for it is only when the pressure is resisted that its effect operates. For example; if the carriages were propelled by some other power at a velocity equal to that with which the water rushed along the horizontal pipe the fluid would evidently exert no impulsive effort on the piston. If the carriages were propelled with half the velocity of the fluid, then only half the impulsive effort would be exerted; and not until the train was stationary, would the full pressure of the fluid be brought to bear on the piston. The whole of Mr. Shuttleworth's

calculations of the power to be derived from hydraulic propulsion would, consequently, only apply to pressure against a stationary resistance; so soon as the train was put in motion the power exerted on the piston would diminish and would continue to decrease in proportion to the increase of speed attained.

One of the objections urged against the system of propulsion by locomotive engines is the great waste of power occasioned by the weight of the engine and tender, yet Mr. Shuttleworth seems to have entirely overlooked the fact, that the same objection applies, in a tenfold degree, to his plan of hydraulic propulsion. He has, indeed, no heavy engine to propel, but the weight and friction of the water, which constitutes his moving power, offer a far greater resistance to motion than an engine and tender. The length of each section of propulsion piping is proposed to be only 70 yards, yet towards the end of that short length the weight of water to be propelled would amount to nearly 5 tons. This weight of water would have to be put in motion with great velocity, with the additional objection of being exposed *throughout its whole course* to retardation by friction in the pipe; whereas the friction of a locomotive engine acts only on those points of the rails whereon the wheels rest. The loss of power by retardation in the tube is, indeed, taken into account by Mr. Shuttleworth, but he appears to overlook the fact that this loss is occasioned by communicating motion to his moving power. The amount of power lost by propelling the water through the pipe is much greater than would at first be supposed. Mr. Shuttleworth himself estimates that his calculated initial velocity of 67⅞ miles an hour would be reduced in a length of pipe of only 70 yards, to 29½ miles an hour; and in another part of his pamphlet it appears that the estimated initial propulsive power of 693 horses (!) would be reduced, after passing through 70 yards of piping of one foot diameter, to 71 H. P. We have thus, by Mr. Shuttleworth's own showing, a power of 622 horses absolutely lost in propelling the moving power; and that too for the short distance of only 70 yards! Surely no system of railway propulsion was ever before proposed, which by the statement of its inventor exhibited such a waste as this; and yet it is proposed as a means of economizing power!

Nor is this all. An enormous waste would arise also from the attempt to regulate the speed communicated by a power varying, by the estimate, from 693 horses to 71, in the space of 70 yards. To obviate the objection which would be urged against the plan, were the rates of speed to be so unequal, Mr. Shuttleworth proposes to fix a self-acting throttle-valve at the commencement of each section of propulsion piping, so as to reduce his estimated initial velocity of 67⅞ to 27 miles an hour. Thus nearly two-thirds of the power would be absolutely thrown away for the purpose of regulating the speed to agree with that of the terminal velocity of the water. Mr. S. appears to imagine, however, that this check on the flow of the water, would not diminish the pressure, because, according to the laws of hydrostatics, the pressure is as the base of the resistance, and that the area of the piston would therefore sus-

tain the same pressure however small the opening of communication from the vertical column of water. He forgets that this law obtains only in fluids at rest; and that as soon as the piston moved under the impulse of the whole vertical column of water, the impulsive force would be diminished. If the throttle-valve were so regulated as to reduce the velocity to 27 miles an hour, the pressure on the piston would correspond with that velocity, and not with the pressure of the whole vertical column. All the force lost by checking the water at the throttle-valve would consequently be so much power wasted.

It might be supposed from the lavish waste of power which is exhibited throughout the whole plan of the hydraulic railway, that the inventor had at command the falls of Niagara every 200 yards of his proposed line; the waters of which he could send rushing through the pipes without any limitation. Not so, however, for every drop of water thus uselessly squandered is to be forced back again into artificial reservoirs. Of these reservoirs, indeed, though they form an essential part of his system, he makes but little mention. In the construction of a railway on the hydraulic propulsion plan, they would, we conceive, figure rather prominently among the items of expenditure, and add very materially to the engineering "difficulties" of any line of railway. The erection of immense towers 200 feet high every 200 yards, would present formidable obstacles to the trial of such a mode of railway propulsion, even did it present theoretically much greater advantages than those claimed for the hydraulic; and unless our views are exceedingly erroneous, the plan could never be practically carried into execution, in consequence of the immense waste of power which every part of it presents. We have, we think, pointed out sufficient instances of this waste to justify our opinion, but on reading over Mr. Shuttleworth's "plain statement" others will be found which we have not thought it necessary to enumerate. Objectionable as Mr. Shuttleworth's first plan of the hydraulic railway appeared, we consider it far preferable to his "improved" mode of employing the water propulsively. The principle of exhaustion, on which it depended, is more simple, and its effects would be more certain, and produced with vastly less expenditure of power.

We regret to be obliged to decide so unfavorable on the claims of an invention which bears evident marks of great ingenuity and labor; but we consider it much more to the interest of an inventor who has been misled by the application of erroneous data, to endeavor at once to convince him of his error, than to indulge fallacious hopes, which can only end in more bitter disappointment.

INSTITUTION OF CIVIL ENGINEERS.

"*On some peculiar Changes in the Internal Structure of Iron, independent of, and subsequent to, the several processes of its manufacture.*" By Charles Hood, F. R. A. S., etc.

The singular and important changes in the structure of iron,

which it is the object of this paper to explain, are those which arise in the conversion of the quality of iron, known by the name of "red short iron," which is tough and fibrous, into the brittle and highly crystallized quality known by the name of "cold short iron." This change the author considers has never been attributed (as it ought to be) to the operation of any definite and ascertained law, but has generally, when observed, been supposed to arise from some accidental cause, and been considered as an insolated fact.

The fracture of railway axles, by which some of the most lamentable accidents have occurred, arises from this molecular change in the structure of iron, by which the axles lose a vast proportion of their strength.

The principal causes which produce this change are percussion, heat, and magnetism, and the author traces through a great number of practical cases of ordinary occurrence the joint, as well as the separate effect of these three causes; showing that the rapidity of the change is proportional to the combined action of these several causes, and that in some cases where all the three causes are in operation at the same time, the change of structure is almost instantaneous; while in other cases, where this united operation does not occur, the change is extremely slow, extending over several years before it becomes sensible. Among the examples given, and of which the causes are explained, are the conversion by means of heat, as in the case of wrought iron furnace-bars, and other analogous cases, particularly when any vapor is present: the operation of the tilt hammer in the planishing of iron, by which both vibration and magnetism of the bar is produced, when the temperature is within a certain limit, beyond which limit the bar loses its magnetic power, and no crystallization occurs; and the instance of piston-rods and other cases, where from any accidental circumstance a peculiar jar or vibration has been given to particular parts. The effect of the continual jar or vibration upon the axles of common road carriages is a case of the opposite kind, where, notwithstanding the continual vibration, this molecular change does not take place *when the axle is insulated from the effects of magnetism.* In railway axles, however, the case is very different. The rapid rotation of the axle produces powerful magnetic action, while the friction causes much heat; and these effects, added to the constant percussion which is produced by the peculiar motion of railway wheels, causes the crystallization to be produced with extreme rapidity; the effect being probably further increased in the axles of locomotive engines by the magnetising power of the electricity generated by the effluent steam. The crystallized structure being the natural condition of iron, as well as of several other metals, the author considers that in these changes we observe a constant effort to return from the artificial to the natural and primal condition of the metal, and the conclusion arrived at is, that this crystallization is not necessarily dependent upon time for its development, but is determined by other circumstances of which the principal is undoubtedly vibration: that heat, although it assists, is not essential

to it, but that magnetism, whether induced by percussion or otherwise, is an essential accompaniment of the phenomena. The paper concludes by pointing out the increased effects likely to result from the rigidity of the springs, the looseness of the brasses, and other causes which increase the vibration on the axles of railway carriages.

Several samples of broken railway axles were exhibited; some of them being cut from different parts of the same axles, showed that at the journals, where the vibration was the most intense, the crystallization was increased to a great extent beyond what occurred in other parts of the same axle.

Remarks.—Mr. Moreland had frequently noticed that pins for chains, and pump-rods, although made of the best iron, would, if subjected to concussion, after a certain time break suddenly, and that the fracture would exhibit a large crystallized texture. This was also frequently observed in the broken axles of road-carriages, although they were generally made of iron of the finest quality.

Mr. E. Woods had observed the crystallized fracture in all the broken axles on railways which he had seen.

Mr. Hood exhibited some specimens of broken axles, all of which showed a large crystallized fracture: he believed that the iron from which the majority of them had been made was of the best quality, and in the parts not immediately subjected to concussion the fracture was quite different. One of them had been in use only three months, and had become so brittle that, on attempting to break it, it jarred off at the shoulder of the journal, although an incision was made all round at the spot where it was intended to be broken.

Mr. York would account for the tendency of the axles to break at the journal, by that part being subjected during the process of forging to more hammering than the body.

Mr. Hood agreed that such might be the case, but he conceived that it was more probably produced by cold hammering. He had taken a sample from the body of a broken cranked axle, from the Grand Junction Railway, the iron of which was evidently of the best quality, but at the point of fracture which was certainly at that part where it had been most hammered, the fracture presented a large crystallized texture.

A large anchor, which had been in store for more than a century at Woolwich Dock-yard, and was supposed to be made of extremely good iron, had been recently tested as an experiment, and had broken instantly with a comparatively small strain; the fracture presented very large crystals; in this case he believed the length of time which the anchor had remained in the same position had produced the snme effects as magnetism and vibration.

Mr. Lowe stated that at the gas-works under his direction wrought-iron fire-bars, although more expensive, were generally preferred; a pan of water was kept beneath them, the steam from which would speedily cause them to become magnetic: he had frequently seen these bars, when thrown down, break into three pieces with a large crystallized fracture.

Mr. Miller had frequently seen in manufactories, that when the smiths had forged parts of engine-work which from their intricate forms had required to be much hammered, the ends were jarred off while they were being worked upon. He instanced particularly the side rods of the engine for the 'Lord Melville' steamer, of which, while shutting up the middle, one of the ends of each rod was jarred off and presented large crystals in the fracture; being well assured of the good quality of the iron in the rods, he had the same ends welded on again, and although the circumstance had occurred 20 years since, they were still at work, and had not shown any symptom of weakness. It must be evident that in this case, the fracture and the crystallized appearance of the metal must have been produced by the cold hammering to which it had been subjected.

Mr. York agreed with Mr. Hood in the fact of a change taking place in the texture of the iron, but he was of opinion that it more frequently occurred during than after manipulation; he alluded more particularly to railway axles, in which he believed the injury to be done by the cold hammering or planishing after they were faggoted; he had frequently seen one end of an axle fall off while the other was being hammered; in all such cases, and those of accidental breakage, such as recently occurred on the Versailles Railway, and in other places, the fracture always presented a crystallized appearance.

He then exhibited and described a railway axle, which he stated to possess the combined advantages of rigidity and toughness, and avoiding entirely the crystallization of the iron during the process of manufacture; this he described to be effected by maintaining the axle in a hollow state during the whole operation of hammering, thereby avoiding the vibration and concussion, to which cause he attributed the crystallization of the iron in solid axles, being of opinion that the repeated blows of the hammer on a solid mass, particularly during the process of "planishing," were the chief, if not the only cause of the ductile quality of the iron being destroyed. He stated, that he had made numerous experiments for the purpose of ascertaining this fact, and in every instance when the axle was sound, the iron presented the same crystallized fracture, although the bars, previous to their being welded together were of the most fibrous quality, but if the axle was not quite sound, and the bars not perfectly welded to the centre, then the fracture was somewhat fibrous, the axle being partially hollow and thereby avoiding the vibration to a considerable extent. This fact suggested to him the propriety of keeping the axle hollow; and the mode of manufacture he described to be by taking two dished half-cylindrical bars of iron, of the entire length of the axle, putting them together and welding them under a hammer in swages, by which means the particles are not driven asunder by the heavy blows and the axle of faggot lengthened, but are driven together and towards the centre. The axles produced by this means, he stated to be as perfectly ductile as the bars in the first instance. A further advantage, he stated to consist, in being able to make half the whole length of the axle at one heat; thereby avoiding to a considerable extent the danger

of burning the iron by repeatedly heating it; the iron in the axle he described, as being a uniform cylinder in thickness, and consequently requiring a uniform heat, whereas the external bars of a faggot for a common axle were liable to be burnt, before the centre was heated to a welding state. The diameter of the hollow axle was increased from 3½ inches (the general size of a solid axle) to 4 inches, in order to give a proper degree of rigidity, but without increasing the weight.

The usual proof to which solid railway axles were subjected, was by allowing a weight of 6 cwt. to fall upon them from a height of 9 feet; with that force they were frequently broken at the second blow, and sometimes by the first—he had tried some of the hollow axles, by letting fall upon them a weight of 10 cwt. from a height of 15 feet, without breaking one of them.

Mr. Simpson expressed the obligation of the Institution to Mr. Hood, for bringing before the meeting such an interesting communication, upon a subject which it is of the utmost importance to railways, should be carefully examined. It was to be regretted, that the late period of the Session had prevented the attendance of those members whose attention had been more particularly directed to railways; but on the renewal of the subject next Session, upon the production of the report upon the projected experiments, promised by Mr. Hood, a very useful discussion might be anticipated.

"*Description of the Calder Viaduct, on the Wishaw and Coltness Railway, with the Specifications, Estimates, and a series of Experiments to ascertain the Deflection of two of the Strutted Beams.*" By John Macneill, M. Inst. C. E.

When first the author was called upon to carry out the extension of the Wishaw and Coltness Railway, he found that the funds for that purpose were very limited, and that it was necessary to construct the works in the cheapest manner possible. To accomplish this it was necessary to design and lay out a single line of railway, which would be sufficient to carry on the trade by H. P., but if possible, and consistently with limited funds, to construct the viaduct over the valley of the Calder (the principal work on the railway) in such a manner as to be able to widen it hereafter, and to make it suitable for locomotive power, in the event of the trade being increased, or of the railway forming a part of the great line of communication between England and the West of Scotland. Having these objects in view, and being so restricted in funds, he was obliged to lay out the works in the first instance, very differently from what he otherwise would have done, if there had been ample funds.

The valley of the Calder, which the railway had to cross, was nearly half a mile in length, and the elevation of the line over the surface of the ground, varied from 50 to 130 feet. The first intention was to construct a viaduct, 480 feet in length, of stone arches, 60 feet span and 12 feet wide between the parapets; but as this mode of construction would have been the cause of much expense

when it became necessary to widen the viaduct for a double line of railway, and would also have involved an embankment of nearly 60 feet in height, composed of clay and marl, which was considered unsafe and likely to slip, an effect which subsequent experience on other portions of the line, has since fully proved would have been the case; it was determined to extend the viaduct to about 1200 feet in length, and to construct it of timber resting on stone piers, which allowed the means of widening and strengthening it hereafter, without stopping the trade or incurring more expense than would have been necessary in the first instance, if built to the full dimensions.

The piers and abutments are built hollow, of grey freestone from the adjoining quarry of Dalziel; the trussed wooden beams rest in metal sockets, and the springing plates are laid, for supporting the under arches of bent timbers, which are now in progress of construction, to render the viaduct capable of supporting safely the weight of locomotives and heavier trains than now pass along it by H. P. The usual load for horses is 4 wagons, each weighing 1¼ ton, and carrying 3½ tons of coal; there are frequently 3 of these trains in a single arch of the viaduct at the same time, and 30 loaded wagons weighing 120 tons exclusive of the engine and tender, have frequently been taken over; on one occasion a train consisting of 65 loaded wagons of 4 tons each, making a gross load (including the engine and tender) of 279 tons was taken over the viaduct, but the usual load is restricted to 30 tons, until the under arches are fixed.

The details of the construction of the general work are then given, and the total cost of the single width is stated to be about £15,000; this sum includes the metal castings for the future widening and when the strengthening and widening of the whole will be completed the total cost will not exceed £25,000, which is stated to be a low price for a viaduct of 1200 feet long, and varying from 50 to 130 feet in height.

A description is then given of the experiments upon the deflection of a trussed beam. Two stone piers were erected 100 feet apart, with metal caps and sockets built into them; two beams were laid and strapped together and the struts fixed, precisely as they would have been in the bridge; along each side of these beams, but quite unconnected with them, posts are driven in the ground, to which a horizontal beam was attached; six rods of deal carefully divided into inches and tenths, were then screwed to the outside faces of the beams. The beams were, in the first instance, brought as near as possible to a horizontal line, by means of a spirit level, and the zero points on the rods made to correspond with a fixed line on the horizontal bar. When the beams were loaded, and the deflection from the original level took place, it was marked by the divisions on the index rods, which being firmly screwed to the beams rose or fell with them, and showed the quantity of deflection as marked by the line on the horizontal bar; after each load was put on the beams, it was allowed to remain an hour or two before the deflection was measured, and after the load was taken

off, the deflection was again measured at an interval of some hours to ascertain the permanent set, before another load was put on. The load made use of was railway bars; they were distributed over the beams in various situations, and in various quantities, varying from 1 to 60 tons: the results of which are stated in a series of elaborate tables: and a large collection of diagrams show the situation and form of the load and the space covered at each experiment. By examining these diagrams, the situation of the load, its weight, and the deflection caused by it, will be at once seen; the results of these weights are given in the tables in feet and decimals, which will be more satisfactory than the diagrams alone would be, to those who may wish to make any calculation, or to form a practical rule upon them for their own guidance.

The appendix contains the specifications for all the artificers' work, with the dimensions of the several parts and the priced estimates;—the drawings accompanying the paper were executed by Mr. Macneill's assistant, George Ellis, Assoc. Inst. C. E.

NOTES ON STEAM NAVIGATION.

Paddle Floats are usually of fir 3 in. thick or elm, 2 1-2 in thick. Each float should consist of only one piece, either from being cut off a plank as wide as the float, or from the pieces being bolted together edgeways if consisting of more than one. These bolts should go right through the float edgeways with a head on the one end and clinched on a ring at the other. There should be three in each float, and in distributing them care should be taken that they do not come in the way of the bolts which attach the floats to the arms.

Paddle bolts and plates constitute an item of considerable expenditure, especially if the ship's carpenter is negligent in screwing up the bolts firmly. New floats are particularly liable to become loose from the compression of the timber, and the bolts should therefore be tightened on every convenient opportunity. It is not uncommon to nick the thread of each paddle bolt with a chisel to prevent the nut from unscrewing, but this will seldom be necessary if the bolts be properly screwed up. When a float is broken, which will sometimes occur in a heavy sea, some of the paddle bolts will generally be lost, but none ought to be lost from any other cause. The carpenter in getting new bolts should always fetch back the old ones, if only to show that there has been no considerable loss from negligence. On one of the outward voyages of the British Queen she lost every float on the weather wheel, and was placed in considerable peril in consequence. This we are inclined to attribiute to the circumstance of the bolts not having been tightened after they had been shifted. The vessel on the occasion to which we refer had been in dock, and all the floats had been removed to enable her to go in. When she came out the floats were replaced, and we doubt not the bolts were screwed as tight as possible.

This was in London: the vessel then started for Southampton, where the bolts should all have been tightened before she put to sea; but this we believe was not done, and the exposed wheel lost all its floats in consequence. Some of the floats indeed were probably broken by the violence of the waves, but the greater number we suspect were lost from the slackness of the bolts.

Against the rapid erosion of the paddle bolts by the sea water we know of no defence except frequent painting. The wheels should be well painted with red lead about four times a year. Red lead is, we think, a better protection to the iron than coal tar, and is much more manageable in its application. It will penetrate into all the joints and minute interstices which coal tar will not do, and will also adhere to the iron more firmly. Coal tar will sometimes peel off, especially if the wheel has been at all wet at the time of its application; and the iron will not unfrequently rust beneath the coal tar.

As paddle bolts are an article of large consumption, it is of course desirable to produce them with as little labor as possible. The practice of the London engineers is to wind a bar of square iron round an upright mandril fixed in the ground in the same manner as the links of cables are made, and then to cut every round of the spiral in two places; so that every round of the spiral will make two bolts. The mandril must of course be of the figure formed by placing two bolts with the point of the one touching the hook of the other. The nuts of the paddle bolts should not be hexagonal but square, and the carpenter should be provided with two or three good stout spanners that will fit on the nuts easily. These spanners should be single ended; the handles should be straight, and furnished with a hole at the end, through which a rope yarn should be rove. Whenever the spanner is used, the rope yarn should be tied to the rim of the wheel, so as to prevent the spanner from being lost should it happen to slip or fall from the man's hands into the water. Sufficient length of rope yarn should of course be left to permit the spanner to be wrought without impediment. The nuts of the paddle bolts may be quite well stamped in a die; a good stout punching press will answer very well for the compressing power.

Horses power.—There is a blessed uncertainty among engineers as to what area of piston and length of stroke constitutes a H. P.; in fact every engineer appears to have a measure of his own, whereby about as much confusion is introduced into engine making as would arise among the haberdashers if every shopkeeper had a yard measure of greater or less length than his neighbor. A horse power is as much a conventional unit as a pound avoirdupois, and we think it a disgrace to the Institution of Civil Engineers that it has not accurately defined what a horse power is. Mr. Watt, it is true, determined a horse power to be 33,000lb. raised one foot high in a minute; but, however useful such a standard may be for the power exerted by an engine with the power exerted by horses or any other species of prime mover, it is wholly useless for commer-

cial purposes. In short it may inform you of the power actually exerted by any engine, but not of the number of horses power which a given diameter of cylinder and length of stroke are equivalent to. If a man purchases an engine he is charged at the rate of so many pounds sterling per horse power, and how is he to ascertain whether he has that number of horses power or not? He has no means of finding out, because it has not been defined what a nominal horse power is, and every engineer makes it a different quantity. Thus the West India mail packets are all said to be of the same power, but he will be very far out who shall conclude from thence that all the cylinders are of the same diameter.

Messrs. Maudsley & Co.'s 400 H. P. is about 72 in. diameter of cylinder.

Messrs. Miller & Co.'s 400 H. P. is about 74 in., which is just about as reasonable as that one man's foot should be twelve inches and another only ten. Again a given sized cylinder, if devoted to the propulsion of a vessel through the water, is rated differently from what it would be if used for any purpose on land. And in Messrs. Maudslay's marine engines, while a cylinder of 47⅛ inches diameter and 5 ft. stroke is rated at 80 H. P., if on the side lever plan, a 48 inch cylinder and 5 feet 6 inches stroke is only rated at 75 H. P., if on their double cylinder construction. Such capricious variations appear to us extremely reprehensible, and are calculated, we think, to give a false impression of the force of a new kind of engine or defraud purchasers of a part of their measure in the old kind. The power of an engine ought manifestly to be some function of the cubical capacity of the cylinder, and that function should not be determined by abstract or scientific views, but by the intent to equalize the cost of production for the same power, whatever be the stroke and diameter. In other words an engine of the same power should cost the same money whether its stroke be longer or shorter than that of other engines, any increment in the stroke being so compensated for by a decrement in the diameter, so as to keep the expense of production unaltered. This standard, it is true, would no longer be a measure of the power exerted, but of the expense incurred, and therefore "horses power" might be an inappropriate name for it. But the term horses power is not even now expressive of the real power an engine exerts, at least in common language. The *actual* power is sometimes determined for scientific purposes by means of the indicator, but it is by the *nominal* power that engines are bought and sold and always spoken of, unless when the contrary is expressly stated. The term horse power is therefore as applicable to the proposed new measure as to the existing one, yet we think a better term might be invented.

The following is Boulton and Watt's rule for determining the nominal horses power.

Let D = the diameter of the cylinder in inches.

V = half the velocity of the piston in feet per minute.

Then $\frac{(D^2 - 4\,D)\,V}{2650}$ = the number of nominal horses power.

But how is V to be determined before perhaps the engine has been made? Boulton and Watt fixed upon an empirical velocity for each different length of stroke. The several velocities are as follows.

stroke. ft.	in.	velocity. ft.
2	0	160
5	6	170
3	0	180
3	6	190
4	0	200
4	6	210
5	0	220

And so on with 10 feet of additional velocity for every 6 inches of additional stroke. Yet this rule does not give results answerable to the dimensions observed by Boulton and Watt in their marine engines. Thus the original engines of the Thames and Shannon constructed by Boulton and Watt, were rated at 80 H. P., the cylinders being 47½ in. in diameter, and the length of the stroke 4 feet 6 in. $(47{\cdot}5)^2 - 4\ (47{\cdot}5) = 2066{\cdot}25 \times 105 = 217930 \div 2650 = 83$ H. P. nearly, instead of 80. Land engines of 43½ in. diameter of cylinder and 8 feet stroke, making 16 double strokes in a minute, were rated by Boulton and Watt at 80 H. P. The average effective pressure on the piston is rated at barely 7lb. per square inch, and the power may be thus computed, $(43\frac{1}{2})^2 \times {\cdot}7854 = 1486{\cdot}2 \times$ by 7 and 266, and $\div$ by 33,000 = about 80 H. P. In marine engines a greater area of piston is allowed to represent a horse power than in land engines, because the motion of the piston is supposed to be slower, but the effective force is calculated a little higher, or at 7·3 per square inch.

To heighten all this perplexity, M. Pambour proclaims to all nations that the boiler is the true measure of an engine's power, and with the forwardness proper to a little knowledge, maintains this to be a discovery of his own. All engineers and most amateurs have long known that the power produced by an engine is proportional simply to the steam expended, provided there be no accidental circumstances to influence the result, and that the piston be not made to travel at an extreme velocity. M. Pambour's discovery, therefore, contributes nothing to our knowledge of the subject, unless it be his intention to allege that the power of an engine is to be determined by guaging the boiler instead of the cylinder. If this be his aim we willingly surrender to him the full credit of the ingenious suggestion.

We trust the Institution of Civil Engineers will give their early attention to this subject, and define what function of the length and diameter of a cylinder a horse power should be, so that a uniformity of measurement may be established among engineers, and purchasers may know what they are buying. Should this not be done by the Institution we shall attempt the task ourselves—giving the

proportion of our principal engineers, the rules for finding those proportions, and a new unit of our own.

Surcharged steam.—The question has been frequently raised whether steam to which a high temperature has been imparted without increasing its elasticity is more economical than common steam. The specific heat of steam has been found by experiment to be 847, that of water being 1, and if this result is to be relied on, there appears to be a saving worth attending to in the use of surcharged steam. Yet it appears questionable to us whether the specific heat of steam is not the same as water, the apparent diversity arising from some error in the experiment, which indeed in researches of such delicacy it is almost impossible to exclude. There are many analogies in favor of the conclusion that the specific heats of bodies are inversely as the atomic weights, and if that doctrine be true, the specific heats of steam and water must be the same. Yet great economy is said to have been realized by the use of surcharged steam, and upon the whole it seems worth while to inquire what amount of benefit may be expected from surcharged steam at a given temperature supposing the specific heat of steam be such as has been determined by experiment.

If θ denote the density of the steam, then $45\left(\frac{1}{\theta}-\theta\right)$ will denote the diminution of temperature when the steam is rarified to unity, or the number of degrees requisite to be added to maintain the temperature unchanged. The latent heat of steam being 1000° the heat necessary to raise water from 60° into steam is 1000 + 152 = 1152°, and if the steam after leaving the water at the temperature of 212° be heated to 600°, and at the same time be prevented from expanding, 600°—212° = 388° = equal the heat requisite to be added if the specific heat of steam were the same as that of water. But the specific heat of steam is ·847.

$$\therefore 1 : \cdot 847 :: 388 : 328$$

Supposing now the steam be allowed to expand,

$$\left.\begin{array}{l} 448+212=660 \\ 448+600=1048 \end{array}\right\} 660 : 1048 :: 100 : 158{\cdot}8 \text{ or say } 159.$$

or the steam when permitted to expand, will occupy 159 volumes at the original atmospheric pressure. The density of the steam when so expanded will be $\frac{100}{159}=\cdot 629$ ∴ $45\left(\frac{1}{\cdot 629}-\cdot 629\right)$ = the heat absorbed by steam during its expansion from 100 to 159 volumes, $45\left(\frac{1}{\cdot 629}-\cdot 229\right) = 45\left(\frac{1}{\cdot 629}-\frac{\cdot 629^2}{\cdot 629}\right) = 45\left(\frac{1}{\cdot 629}-\frac{\cdot 401641}{\cdot 629}\right) = 45\ (\cdot 598359) = 26{\cdot}025015$ degrees. This is the result for air, the specific heat of which is ·2669.

$$\therefore \cdot 2069 : \cdot 847 :: 26 : 82°.$$

The total quantity of heat therefore requisite to produce 159 volumes of surcharged steam of the atmospheric pressure and temperature, 600° is 1152+328+82=1562°. To raise an equal quantity in the common way would require 1831·68°, for

100 : 1152 : : 159 : 1831·68° say 1832.

∴ 1832—1562=270° and 270÷1862= $\frac{1}{6.7}$ of the whole heat; in other words, by surcharging the steam to the temperature of 600° the saving is a little more than a seventh of the whole fuel consumed.

Deck Plates.—Every steam vessel should have an iron deck plate above the steam chest: the fore and aft bearers of the boiler hatch should also be of wrought iron. Boiler plate on edge with angle irons at top and bottom answers well. Dog bolts may still be used in the beams extending from the fore and after to the ship's side, and the knees can be placed as usual.

Safety valve Chest.—The weights should all lie within the chest or within the boiler. The practice of raising the valves by palms acting on the lower extremities of the valve spindles, and attaching the weights *beneath* the valve with a cutter, which admits those weights to be raised without lifting the valve, is, we think, a good practice, The valve can thus be *eased* without opening it, which is done by relieving the valve of its lower weights, the weights *above* the valve still keeping it down, though with a diminished force. By raising the palms still more, the cutter arrives at the end of the slit in the socket; and then the valve is lifted. The safety valve seat should never be driven tight in and rivetted, but attached by means of a weak flange and a few weak bolts so that the valve seat would be raised out of its place by the pressure of the steam before the boiler would be burst. The waste steam pipe should always be attached to the safety valve chest by a socket joint. If fixed by a flange it will speedily be cracked at the neck from the rolling of the chimney, when the vessel is in a sea way, the funnel shrouds never being so tight as to prevent *all* motion of the chimney.

Slide valves.—Messrs. Maudslays make all their slide valves up to 50 H. P., of the long D description, above that power, short D. Their long D's are just the same as those in commun use, but the attachment to the valve rod is at the top instead of at the bottom as is usual. The covers of the valve casings are made so that they may be moved in as the valve faces wear, the bolt holes being oblong, and the part where the joint is faced in the lathe. The joint is made with a piece of sheet lead *not* wrapped with canvass. The valve rods are steel; the long D's are of iron, the short D's of brass. Messrs. Miller & Co. also make their short D's of brass. The practice is an excellent one.

THE ARTESIAN WELL AT GRENELLE, PARIS.

We have at various times given an account of this well, the first description of the labors of M. Mulot, up to the time of his accomplishing the objects in obtaining water, appeared in the *Journal* for April, 1841, p. 131. vol. 4; and in the *Journal* for the following July we gave a further account, explaining the size of the tubes and the

geological character of the strata through which the boring passed. All the reports that have recently appeared in different publications nearly correspond with our reports, and the engraving lately published in Paris, showing the strata does not differ much from our description, but it gives the strata more minutely, which we now give in a tabular form. It will be perceived that the formation is identical with that of the London Basin below the London Clay.

Depth in ft.	STRATA.	Formation.
	Gravel and sand	
13.		
	Cockle Shells	
	Quartoze Sand with fine particles of sulphuret of iron	
	Fine Sand	Plastic Clay.
	Argillaceous Sand	
	Mottled Clay	
	Sand and Clay with nodules of Limestone	
189.		
	White Chalk with layers of flints	
328.		
	White Chalk alternating with stata of dolomite and small pieces of silex	White Chalk.
886.		
	Gray chalk with small particles of silex	
1049.		Gray Chalk.
	Gray Chalk, compact without silex	
1453.		
	Green Chalk and green particles of the silicate of iron	
	Blue argillaceous Chalk	Chalk Marl.
	Blue argillaceous and sandy chalk, with particles of mica, and veins of green chalk	
1634.		
	Clay with iron pyrites, nodules of the phosphate of lime and fossil debris	
	Green Sand	
	Clay and Greenish Sand with grains of quartz	Gault.
	Argillaceous Sand	
	Green and White Sand	
1794.		
	Water	

PORTION OF THE MESSAGE OF THE GOVERNOR OF PENNSYLVANIA, RELATIVE TO INTERNAL IMPROVEMENTS.

No bids were received for the purchase of the public improvements of the State.

"The revenues upon our public works have not diminished in any proportion to the extent of the embarrassments which have

been thrown in the way of trade. It will be seen by referring to the report of the Canal Commissioners, which will shortly be laid before you, that notwithstanding the scarcity and depreciation of money, the impaired condition of credit, and the enormous rates of exchanges, the receipts from tolls for the fiscal year, ending the 30th of November, 1842, amount to $920,499 42

The expenditures, for all purposes for the nine months commencing on the 1st March and ending 30th November, 1842, amount to 390,046 70

Leaving an excess of receipts for the year, over the expenses of nine months of 530,452 72

notwithstanding the decrease in tolls has been $169,396 61

The receipts and expenditures on the main lines have been as follows:

	Tolls received in 1842.	All expenses and liabilities for 9 months.
Columbia Railroad,	$357,461 50	$132,499 45
Eastern & Juniata, Divisions,	195,780 16	45,072 12
Alleghany Portage Railroad,	124,258 40	96,528 63
Western Division,	85,449 42	26,080 00
	$762,949 42	$300,080 20

Leaving an excess of tolls over expenditures of $462,769 28, on the above usually denominated THE MAIN LINE from Philadelphia to Pittsburg.

On the Delaware Division and other branches of the Canals, the excess of tolls over expenditures, during the same period, has been $67,683 44.—It is worthy too of remark that the expenses for repairs alone for the nine months have been only $164,526 30.

This exhibit cannot fail to inspire us with increased confidence in the ultimate value and usefulness of our public works, strengthened as it is by the fact, that there has been a falling-off in the canal tolls of New York, for the fiscal year ending 30th November, of $284,361 89.

The Governor then speaks of the delapidated condition of the works and the heavy amount required to put them in navigable condition when he came into power—the amount of the debt due for ordinary repairs, unprovided for, etc., which amounted in the aggregate to $2,367,566, which has been hanging like an incubus on the whole system, and which has contributed much to embarrass its operation for the last few years. These renewals have been made, and the expenses for repairs will be light for several years to come.

The bridges which cross the state Canals, and which have been heretofore kept in repair at the expense of the state, the Governor suggests, ought hereafter to be kept in repair at the expense of individuals and counties, for whose use they were constructed.

The Governor also alludes to combinations among a few private companies to monopolize all the advantages from the carrying trade on the public works at their own prices, and hopes that the recent conviction at Pittsburg will remedy the evils complained of.

He refers the Legislature to the Canal Commissioners Report for other grievances complained of, which the Legislature ought to remedy.

Nothing has been done with regard to the incorporation of private Companies, to take and finish those portions of the public works that remain in an unfinished state.

Claims by Domestic Creditors to the amount of $1,191,710 23 have been entered on the books of the Auditor General, and only an instalment of 20 per cent., and the interest amounting to $209,589 43 have been paid. The Governor also calls the attention of the Legislature to the amount due the laborers who keep the improvements in repair, and who, the message states, have been heretofore overlooked.

ON THE ACTION OF LIGHTNING CONDUCTORS.

At the meeting of the Electrical Society on Tuesday evening, 19th July, a paper on this subject by Mr. Charles Walker, the Secretary, was read. The author entered into a very close investigation of the most important experiments that have been adduced in illustration of the nature of these instruments and stated that discharges of Leyden batteries have been very generally selected as representatives of lightning flashes. He then showed the great difference between the visible character of the two flashes, and analyzed the cause on which each depends; demonstrating that the only case in which the resemblance is in any degree to be traced, is when a Leyden discharge fractures the glass, and passes directly between the coatings; and that in all other cases the said discharge is the result of two forces acting counter to each other. Thus he reaches his first conclusion, that the discharge of a Leyden jar does not resemble a flash of lightning; and therefore that Leyden jars should not be employed in these experiments. He then said that many points on which philosophers of the present day differ, are in connexion with the results of the Leyden experiments; and hence if it can be shown that these experiments ought to be excluded, the at present complicated inquiry will be much simplified. He proceeded to trace the close resemblance between the discharge of a prime conductor and a cloud, illustrating his opinion by the aid of the magnificent machine belonging to the Polytechnic Institution; and showed that experiments with this conductor are in all essential points legitimate. He then described an extensive series of experiments to prove that a wire on which sparks are thrown from the prime conductor represents a lightning-rod; and then that sparks will pass from such a wire, and therefore from a lightning-rod, to vicinal conducting bodies. This last position was illustrat-

ed in a general manner by an assistant holding in his hand a glass rod surmounted by a brass ball; the ball was connected by stout wire with the gas-burners of the room, and thus when sparks were thrown on it from the conductor the electricity passed into a good discharging train to the earth. Now, while this took place, the application of a piece of metal to any part of the wire produced a spark; and not only so, but the same could be obtained from any of the gas-burners in any part of the roo ; and even when the writer descended into the workshops, two stories below the machine sparks could be obtained from the burners there, which were indeed very much out of the direct line of circuit, so great is the desire of the electric current to use a wide path. This is the source of danger alluded to in the paper on Brixton church, reported in the last *Journal*. However, as the wires in this, as in several other similar experiments, were not directly between the conductor and the earth, the following arrangement was made, which answers every condition, and the general result of which proves that the wires above described do act as lightning-rods. Attached to the prime conductor of the machine was a thick brass rod, terminating in a five-inch ball; immediately beneath this was erected a similar rod surmounted by a ball. This rod was screwed into a small brass disc on the floor, and was considered a perfect representation of a lightning-rod, when sparks or flashes were passed into it. Near this a shorter and smaller rod (also terminating in a ball) was held; when the end of this rod touched the brass disc, no sparks passed between the two, when it did not touch, sparks passed in abundance. Much of the value of the inquiry was shown to depend on this experiment. If the former state of things represents what occurs in nature, there is no danger of a lateral spark; but if the latter, the danger is great. That metallic contact in this experiment prevented the appearance of sparks is an experimental proof of the safety resulting from the metallic connexions formerly recommended. These latter results are given in explanation of the well-known experiment of the two metallic discs; and Mr. Walker shows that no lateral discharge takes place between these discs, because the vicinal metal is in contact with the lower disc. While, therefore, the author agrees in recognising the value of lightning-rods, he has strong reason to believe that this lateral spark will occur unless proper precautions are taken; and though he differs in some degree from others, he does so in a feeling of perfect good-fellowship, and expresses a willingness to forsake his opinions whenever they are shown to be untenable. He states, in conclusion, that even if he is in error, still science will have gained something; for the received opinions will then have been able to withstand another assault, and will only stand the firmer.

PATENT STUCCO PAINT CEMENT.

In a former number we slightly alluded to this new cement, deferring until we had an opportunity of examining into its qualities,

to recommend it to the notice of the profession, which we are now enabled to do, after having carefully investigated its properties, and examined several samples of the cement, at Messrs. Mann's, Maiden-lane, in the City. It appears to be a cement possessing superior qualities, and to be well adapted for external works, particularly in exposed and damp situations, such as on the sea coast, and south-western aspects. At Plymouth, where the cement is manufactured by Messrs. Johns, the patentees, and where the principal ingredient is obtained, it has been tried for the last three years, and subjected to the most rigid tests with perfect success. Its strong adhesive properties cause it to adhere to almost any substance; specimens may be seen on glass, wood, slate, tile, and brick. The nature of the materials of which the cement is composed, renders it highly repellant of water, and impervious to wet or damp. It is sold in a semi-liquid state, which has the appearance of white lead; and when used it is mixed with three times its weight of sharp sand to the consistency of mortar, and laid on the wall with a trowel in the same manner as cement, and with about the same labor. It is finished off at once, with either a fine or a coarse coat, as may be desired; it dries gradually, and in two or three days time the surface becomes as hard as stone, to which it has all the appearance, without coloring. It may likewise be used for interiors, and painted over within a few days, a couple of coats being sufficient to cover it, as the cement is not of that absorbent character as stucco or roman cement.

The cost of the fluid cement is 14s. per cwt., and for covering a yard superficial of brick-work, it requires 7 lbs. of cement, and 21 lbs. of sand, or 4 lbs. of cement, and 12 lbs. of sand, if laid on a coat of plastering, or 1 cwt. of cement will take one bushel of sand, and cover 14 yards. The prime cost, including labor, is about 1s. 6d. per square yard, which is a low price, considering the excellent qualities of the material, and that it does not require coloring. We strongly recommend the architect to give the cement a fair trial. Some specimens may be seen at the office of the Journal.

Alabama Gold.—The East Alabamian says: The broken lands in some parts of Randolph and Tallapoosa counties are said to teem with the precious mineral. In the latter county, a considerable number of persons have recently made entries of land with a view to commence mining operations immediately. The gold is found, we are informed, in what miners term "rock veins;" and a yield is obtained by crushing the rock in some rude wooden contrivance, of two or three dwts. per day to the hand. In a short time we have confident expectations the pure bullion will be very plentiful in this vicinity.

A wire rope 5,300 yards in length and weighing twelve tons has been manufactured at Newcastle-upon-Tyne, for the inclined plane on the Liege and Antwerp railway.